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INVESTIGATION OF A SECTIONAL FAIRED TOWLINE MODIFIED WITH RESTRAINER RINGS.

by

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ABSTRACT

INTRODUCTION

Pursuant to the Naval Ship Systems Command (NSSC) Variable Depth Sonar (VDS) Systems Sub-project S2720, Fleet Support Development Task 11309, the Naval Ship Research and Development Center (NSRDC) initiated an investigative program to improve the towing performance of the towline used with the AN/SQA-10 VDS system[1]. The SQA-10 towline with sectional or continuous rubber fairing has been plagued with problems of kiting and fairing breakage caused by the hydrodynamic force acting on the towline during towing.

A component of the hydrodynamic force acts longitudinally down the cable during towing and causes the fairing to stack progressively tighter down the cable. Often this force is large enough to cause the fairing sections to bind and/or cut into the succeeding fairing sections. This damage or binding of the fairing sections may prevent the fairing from swiveling about the cable, which may lead to the development of side forces that cause the towline to kite.

One device designed by NSRDC to correct the kiting and breakage difficulties is the DTMB Mark I Cable-Fairing Restrainer[1]. This restrainer was developed for use with rubber fairing but the ring of the Mark I Restrainer may be used with sectional fairing. It is installed at intermediate points on the cable to restrain the fairing from moving axially along the cable. The restrainer ring distributes the longitudinal force along the cable during towing, thereby limiting the force build-up and allowing the fairing to swivel freely while being towed.

ABSTRACT

To determine the effectiveness of the rings to prevent kiting and fairing damage at high speed, NSRDC modified a SQA-10 towline using restrainer rings with a 5-foot spacing. The modified towline was installed in place of the standard fleet SQA-10 towline on the USS PURVIS (DD 709) and tests were conducted at sea to evaluate its performance.

[1] References are listed on page 11.

This report describes the equipment and procedures used in the investigation, presents the results of the tests conducted at sea, and gives conclusions based on the results.

DESCRIPTION OF EQUIPMENT

A standard fleet AN/SQA-10 VDS towline was modified by installing DTMB Mark I Cable-Fairing Restrainer rings at 5-foot intervals along its length. A segment of the modified towline consisting of towcable, fairing, and restrainer ring is shown in Figure 1. The towcable provides the mechanical support to tow the SQA-10 body and contains the conductors for transmitting electrical signals between the ship and the body. The towcable is a 500-foot length of 1.345-inch diameter, double-armored cable comprised of 48 strands of galvanized, improved, plow-steel armor and 67 electrical conductors. The fairing used on the cable is the same as that used on fleet operational towlines except for the fairing headpiece at each restrainer ring. This headpiece is made of brass with a slot cut to fit around the ring. The parts of the fairing and restrainer-ring assembly are shown in Figure 2. Each cable-fairing restrainer ring is a 2-piece brass collar fitted around a 2-piece sand-impregnated polyvinyl liner and is fastened around the cable, as shown in Figure 3, with six specially hardened cap screws. The ring and associated hardware, when properly installed, is capable of holding axial loads in excess of 2000 pounds. A detailed description and method for installing the ring are given in Reference 2. The additional effective cable diameter when using the ring dictates the reduction in cable length from the standard 600 feet.

The instrumentation consisted of the standard body pitch and roll sensors located within the SQA-10 transducer, a cable payed out (CPO) indicator, and a kite angle indicator. The body angle and CPO measurements were read directly from the transducer readouts in the sonar room. The kite angle of the towline is defined as the angle between a normal projection of the towline on a transverse vertical plane and a vertical

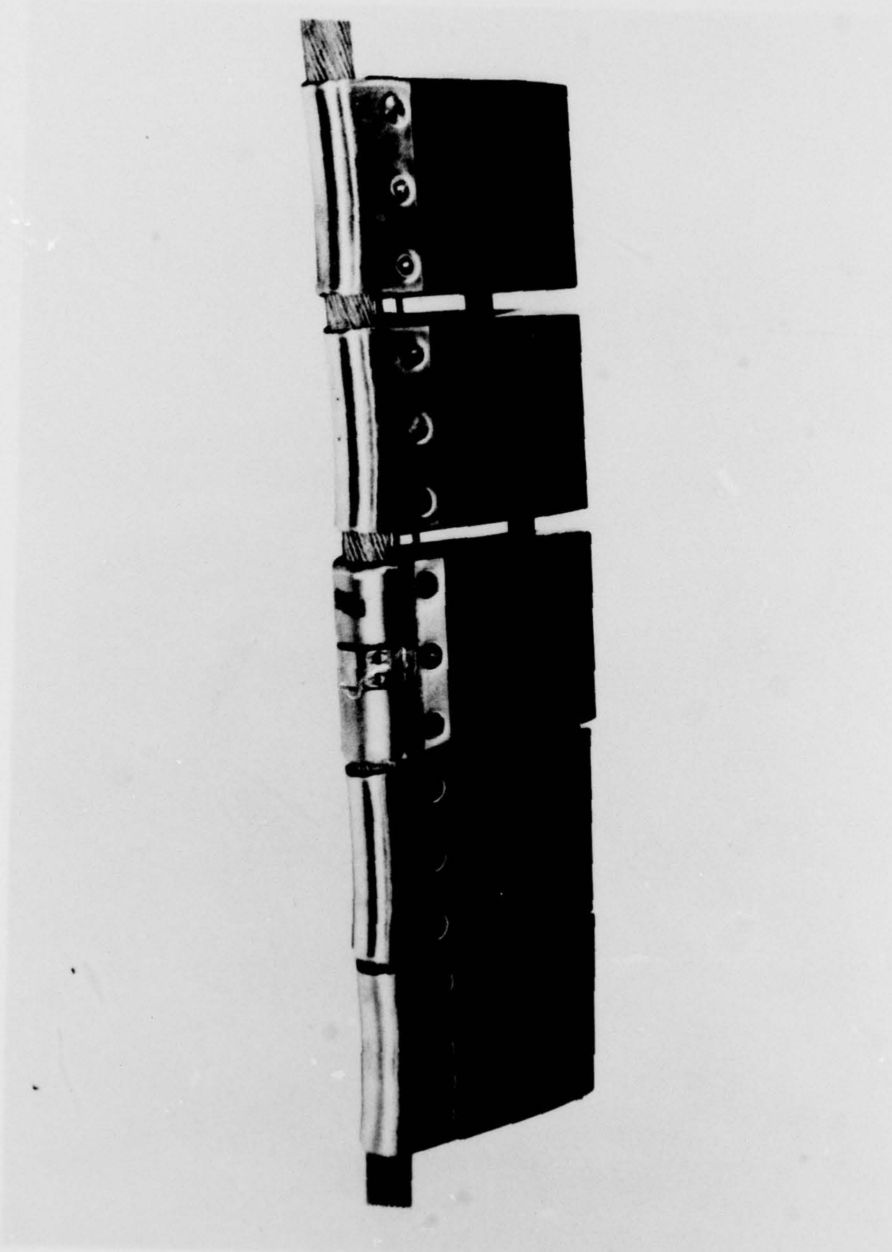

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Figure 1 - Segment of Modified Towline

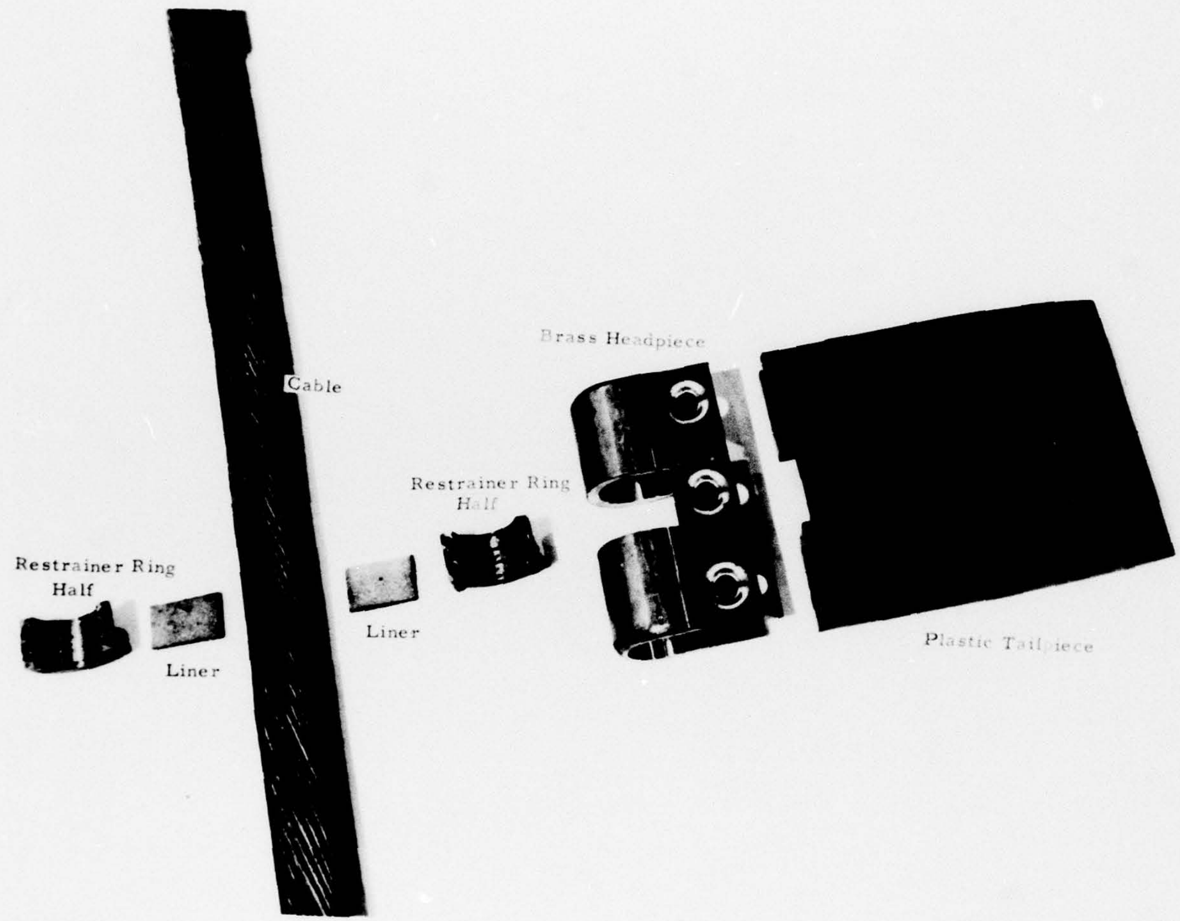

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Figure 2 - Disassembled Restrainer Ring and Fairing

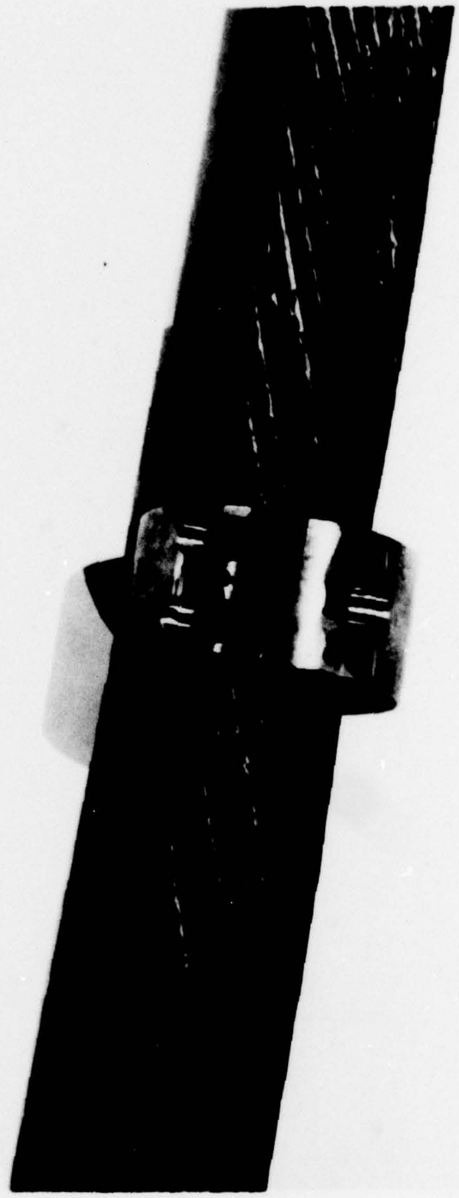

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Figure 3 - Restrainer Ring and Towcable

line in that plane. It was measured using a device that consists of a piece of clear sheet plastic on which lines have been scribed in 5-degree increments. When the device is properly oriented, kite angle can be estimated.

TEST PROCEDURES

The modified towline was installed on the ship using the standard technique outlined in Reference 1. The body attitude and CPO sensors were checked for proper operation. Since the body roll and pitch sensors are in the pendulous sonar transducer, the transducer was locked in place within the body so that the transducer angle and body pitch angle were identical. For the calibration, angles of pitch and roll were established by blocking the body and measuring the angle with a bubble-level protractor. The resulting angles read on the indicators in the sonar room were correlated with the measured angles. The CPO indicator was calibrated at sea with the ship at zero speed. The towline was payed out in measured 50-foot increments, and CPO indicator readings in the sonar room were correlated with the measured values of towline in the water.

To evaluate the performance of the experimental towline, it is necessary that the body tow at a zero degree roll angle and not influence the performance of the towline. Conversely, to assure that the body performance is satisfactory, the body must be towed with a minimum of influence of the towline. This was accomplished by towing the body at speeds up to 25 knots with 50 feet of cable in the water and obtaining zero roll and kite angles.

For the straight-ahead towing evaluation, the fairing was stacked by towing at a speed of 15 knots with 400 feet of towline in the water for about 15 minutes. Towing tests were then conducted over a speed range from 10 to 25 knots for CPO's of 100, 200, 300, and 400 feet. Roll, pitch, and kite angles were measured for each speed and CPO. Reeling tests were limited to the changes of cable scope for each speed. Kite angles were measured before and after each reeling operation.

For maneuvering tests, the ship performed 360-degree port and starboard minimum radius turns at 20 knots. Kite angles were measured before and after each turn.

To assess the performance of the towline under sustained high speed towing, the cable was payed out to 300 feet and towed for a period of 5 hours at 25 knots. Measurements of the kite angle and observations of the towing attitude were made at 15-minute intervals while roll and pitch attitudes were monitored.

RESULTS AND DISCUSSION

The kite angles and body attitude angles measured during the straight-tow and reeling tests for each speed and CPO are contained in Table 1. As shown in the table, this AN/SQA-10 system using the modified towline exhibited kite angles of 5 degrees or less during straight towing for all speeds up to 25 knots. The results of the reelings tests also are contained in this table since the effects of reeling were obtained at the conclusion of each reeling operation during the straight tow tests. The values of measured kite angle indicate that reeling had little or no effect on stimulating a kiting situation. Throughout these tests, the body pitch angle varied approximately 0.4 degree and roll angle varied between 2 degrees starboard and 4 degrees port. Pitch and roll are not presented for some conditions due to occasional erratic behavior of the pitch-roll indicators.

The maneuvering tests to stimulate a kiting situation resulted in kite angles of 5 degrees starboard or less as measured before and after the minimum radius turns. The pitch and roll angles on completion of the turn were the same as before entering the turn.

During the 25-knot endurance tests, the system towed in a steady manner with kite angles up to 10 degrees. Roll and pitch angles remained relatively constant throught the test.

When the towline and body were retrieved on completion of the towing tests, inspection of the fairing indicated no damage to the fairing sections. No binding and no ring slippage were apparent, and the fairing swiveled freely about the cable.

TABLE 1

Performance of the AN/SQA-10 VDS System with a Modified Towline

Speed, knots	Cable Length, feet	Roll, degrees		Pitch, degrees		Kite Angle, degrees
		port	stbd	nose up	nose down	
10	100	2		1.0		3
	200	3		1.2		5
	300	2				0 to 2
	300			1.2		0
	400	1				5
15	100	2		0.9		0 to 5
	100	1		0.9		0 to 5
	200	1		0.9		0 to 5
	300	2				0 to 5
	400			1.0		0
20	100		2	0.8		0 to 2
	100			0.8		0 to 2
	200			0.8		0
	200			0.8		0
	300			0.9		0 to 5
	400			0.8		0
25	100	0	0	0.8		5
	200	3		0.8		0
	200	2		0.8		0 to 3
	300	4		0.8		0 to 3

NOTE: All kite angles are starboard.

The time allocated for these tests amounted to 10 hours, 8 hours of which were after dark. Consequently, some difficulty was experienced in measuring kite angles. Also, 10 hours of test time are inadequate to predict long term performance of the towline. At the request of the ship, the modified towline was left aboard, and the ship offered to take particular note of its performance and notify NSRDC of any peculiarities.

CONCLUSIONS

Based on the limited test results, the following conclusions are drawn:

1. The DTMB Mark I Cable Fairing Restrainer rings effectively limit the column loading of the fairing and thus prevent extreme kiting and fairing destruction.

2. The restrainer rings do not restrict or impose difficulties in handling the fairing on the towing sheave or drum but reduce the amount of cable that can be stored on the drum.

REFERENCES

1. "Overhaul Manual for Sonar Hoist Mechanism Group AN/SQA-10, AN/SQA-10A, and AN/SQA-10B (U)," NAVSHIPS 097-043-9020 (June 1965) CONFIDENTIAL.

2. Brisbane, A. P., "The DTMB Mark I Cable-Fairing Restrainer," David Taylor Model Basin Report 2009 (May 1965).